GCS - the Next Generation Combustion

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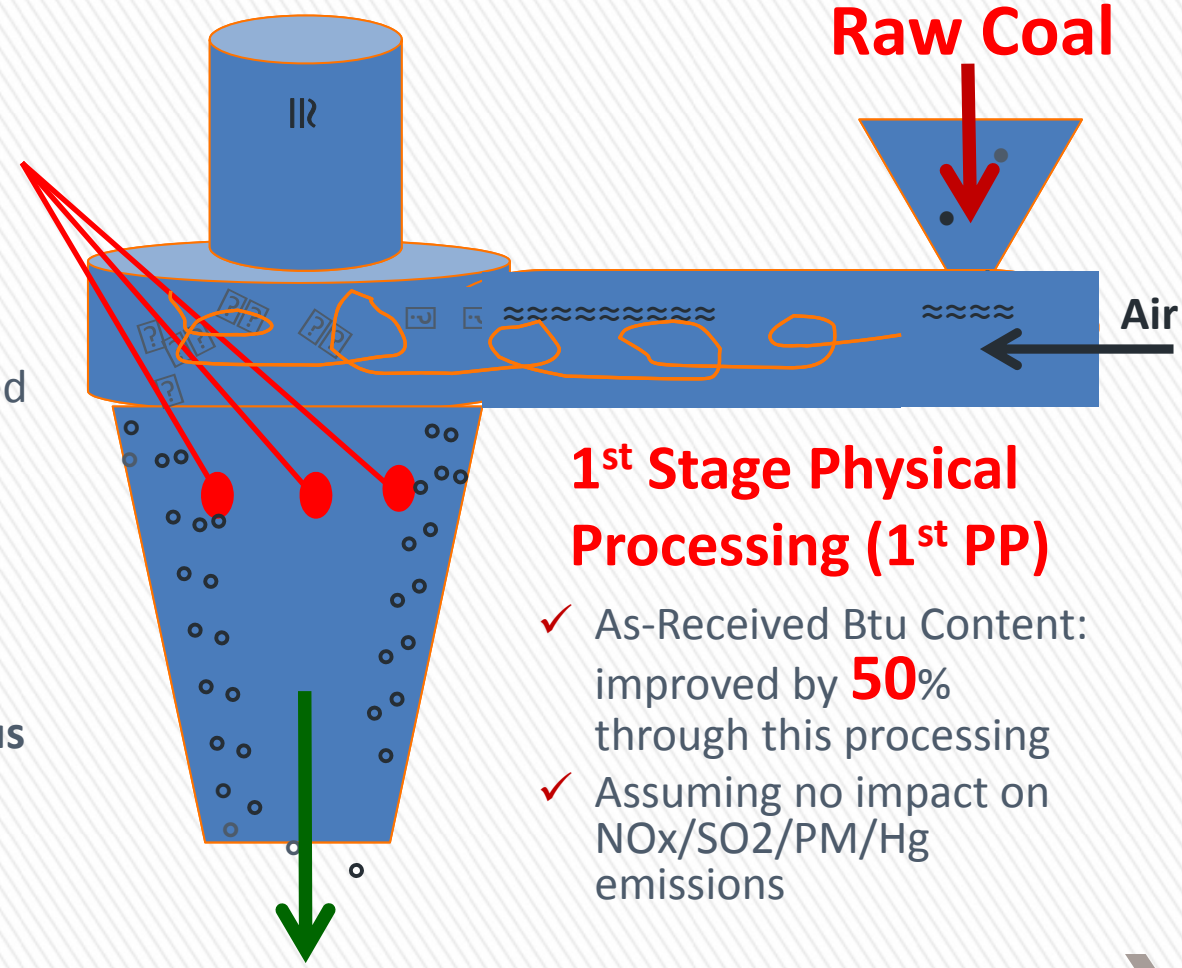
Green Coal Solutions (GCS) Process Overview

2nd Stage Enzymatic Treatment (2nd ET)

- ✓ Sulfur Dioxides (SO_2) reduction **30.8%** (reduced limestone or lime)
- ✓ Nitrogen Oxides (NO_X) reduction **22.4%**
- ✓ **5% improvement in combustion efficiency, thus 5% reduction in CO2**



1st Stage Physical Processing (1st PP)

- ✓ As-Received Btu Content: improved by **50%** through this processing
- ✓ Assuming no impact on NOx/SO2/PM/Hg emissions

Processed Green Coal for Combustion or Storage

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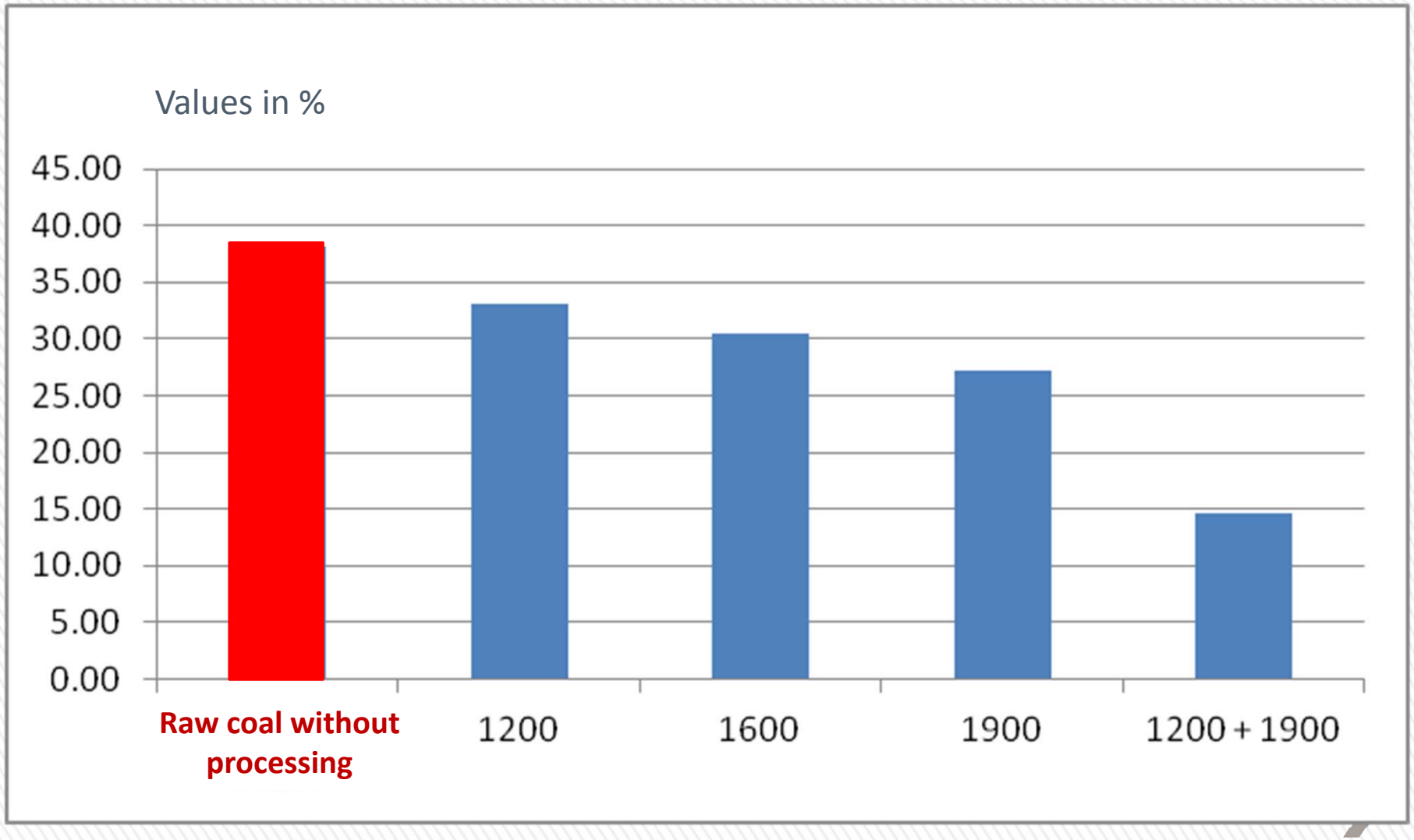
GCS 1st PP Processed Lignite Analysis – Total Moisture



- Total Moisture Content: Reduced by **60%**

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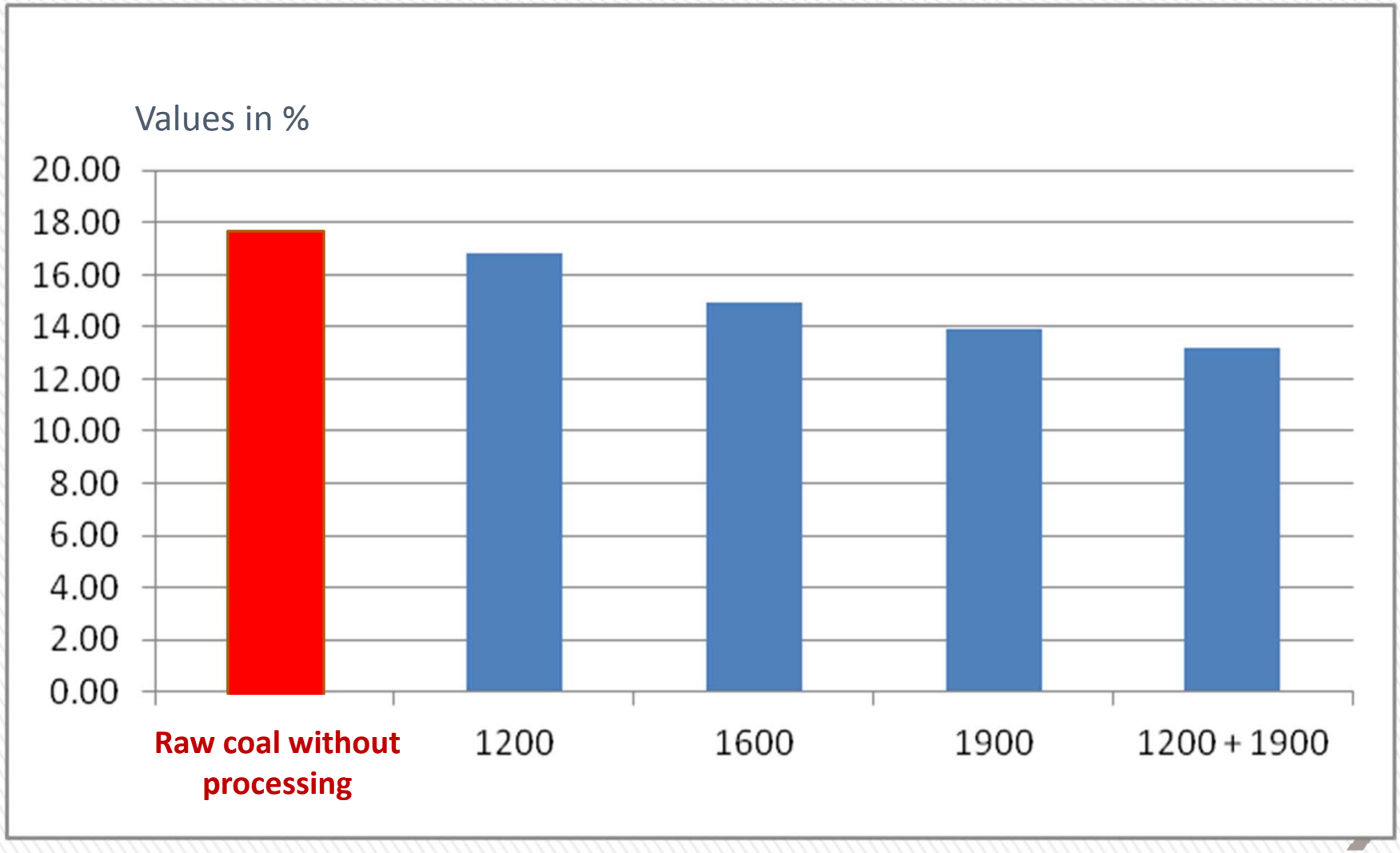
GCS 1st PP Processed Lignite Analysis – Ash Content



- Ash Content: Reduced by **23%**

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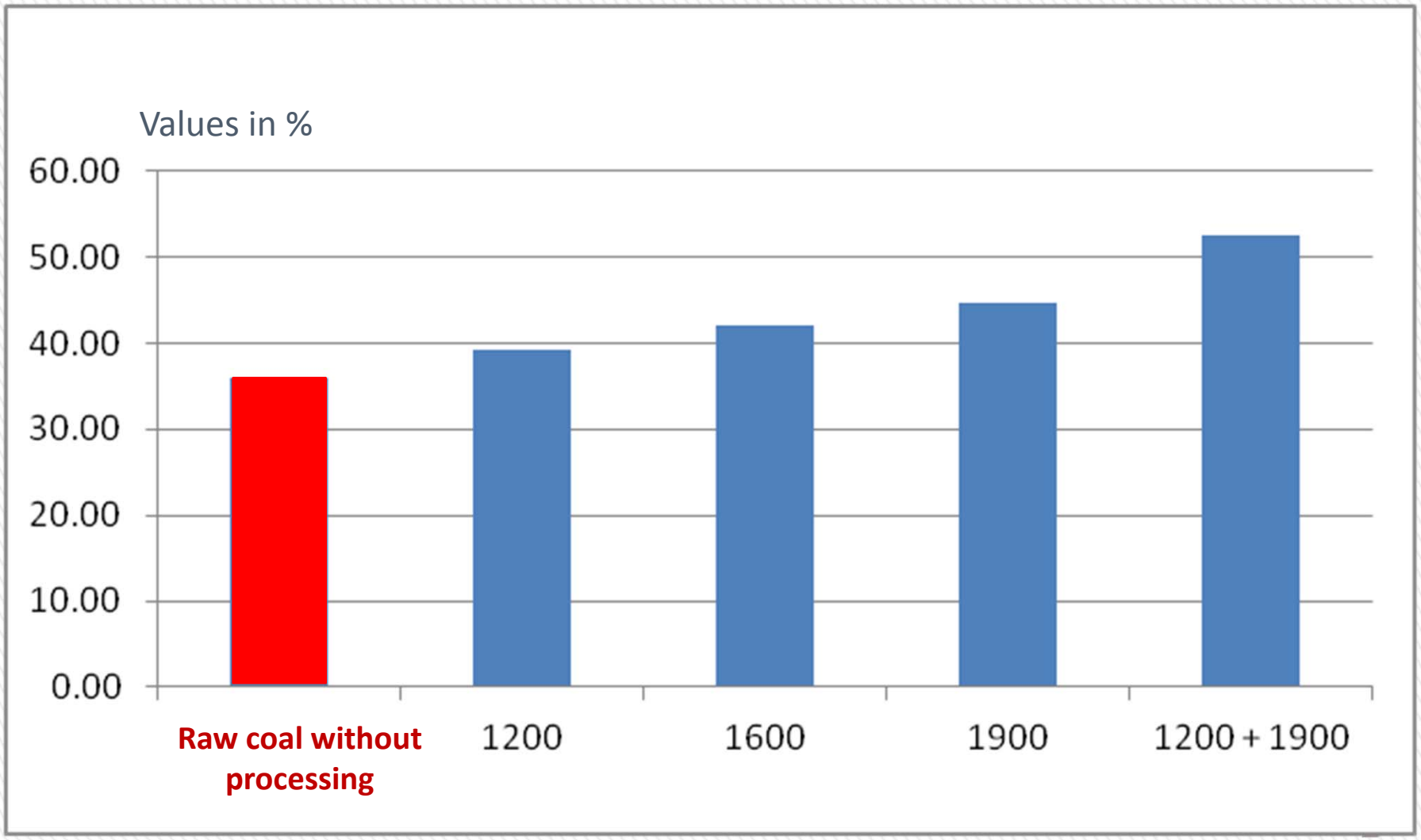
GCS 1st PP Processed Lignite Analysis – Carbon



- As received Carbon: increased by **33%**

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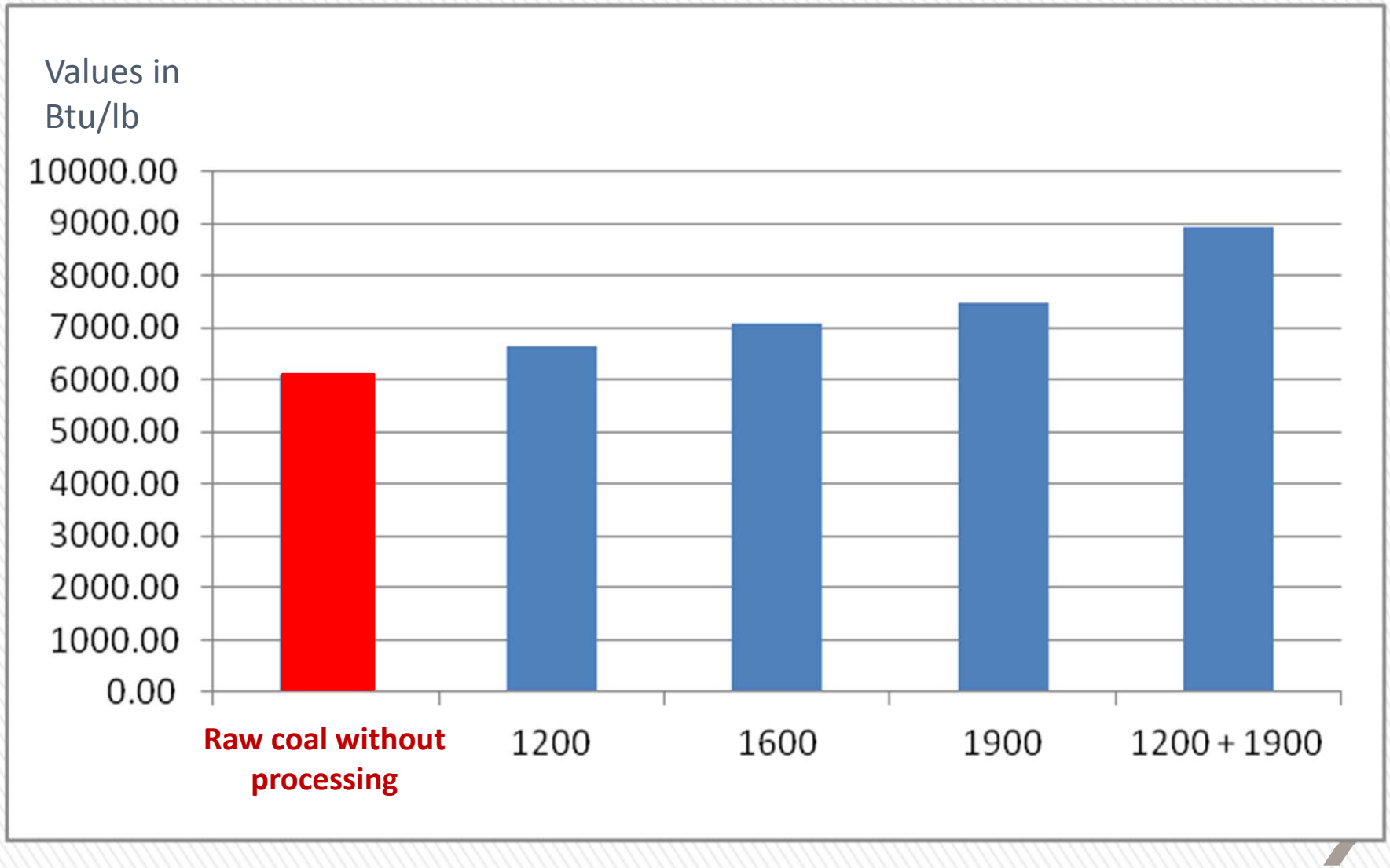
GCS 1st PP Processed Lignite Analysis – Heating Value



- As-Received Btu Content: improved by **50%**

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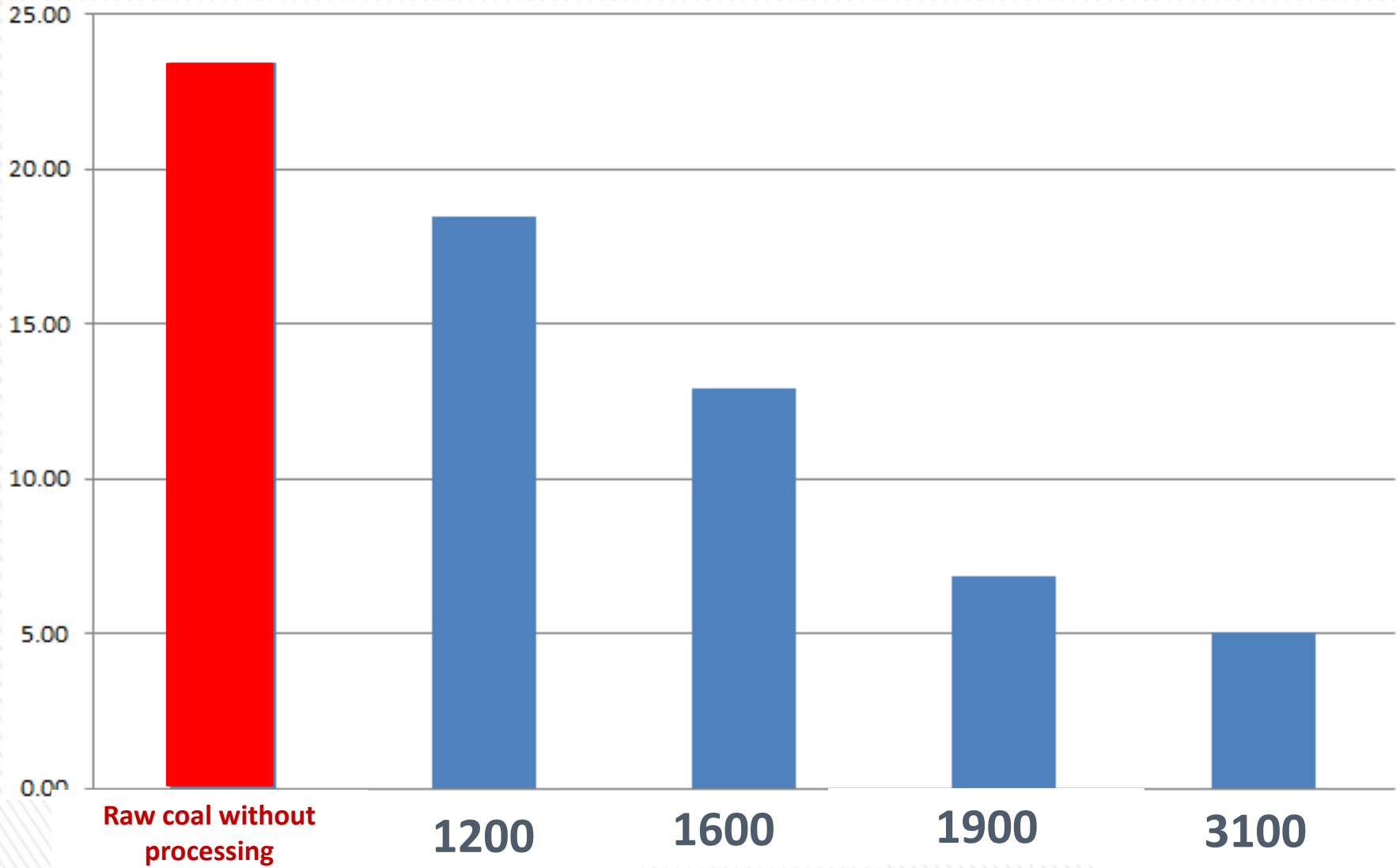
GCS 1st PP Processed PRB Analysis – Total Moisture

Values in %



- Total Moisture Content: Reduced by **79%**

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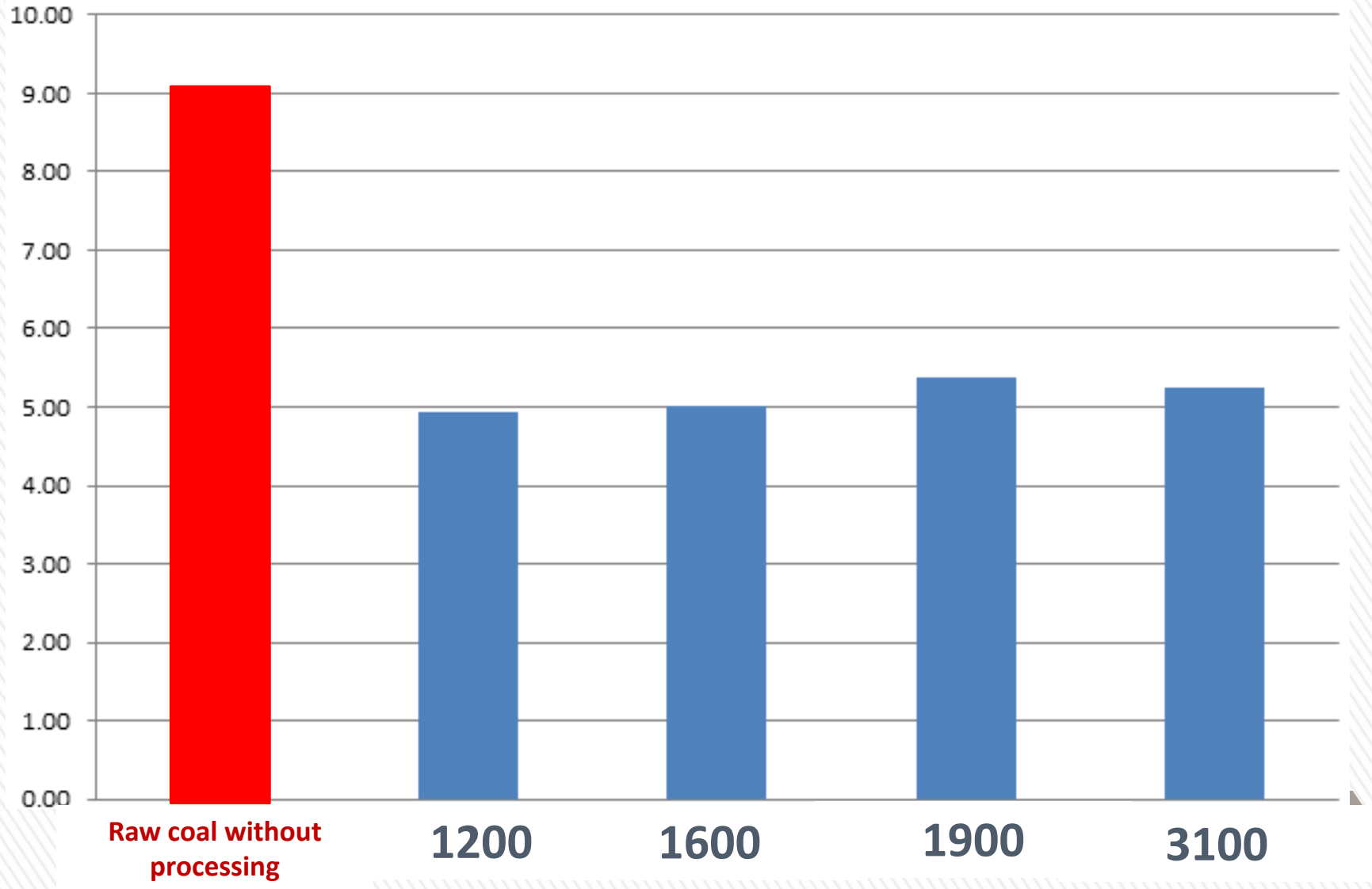
GCS 1st PP Processed PRB Analysis – Ash Content

Values in %



➢ Ash Content: Reduced by **42%**

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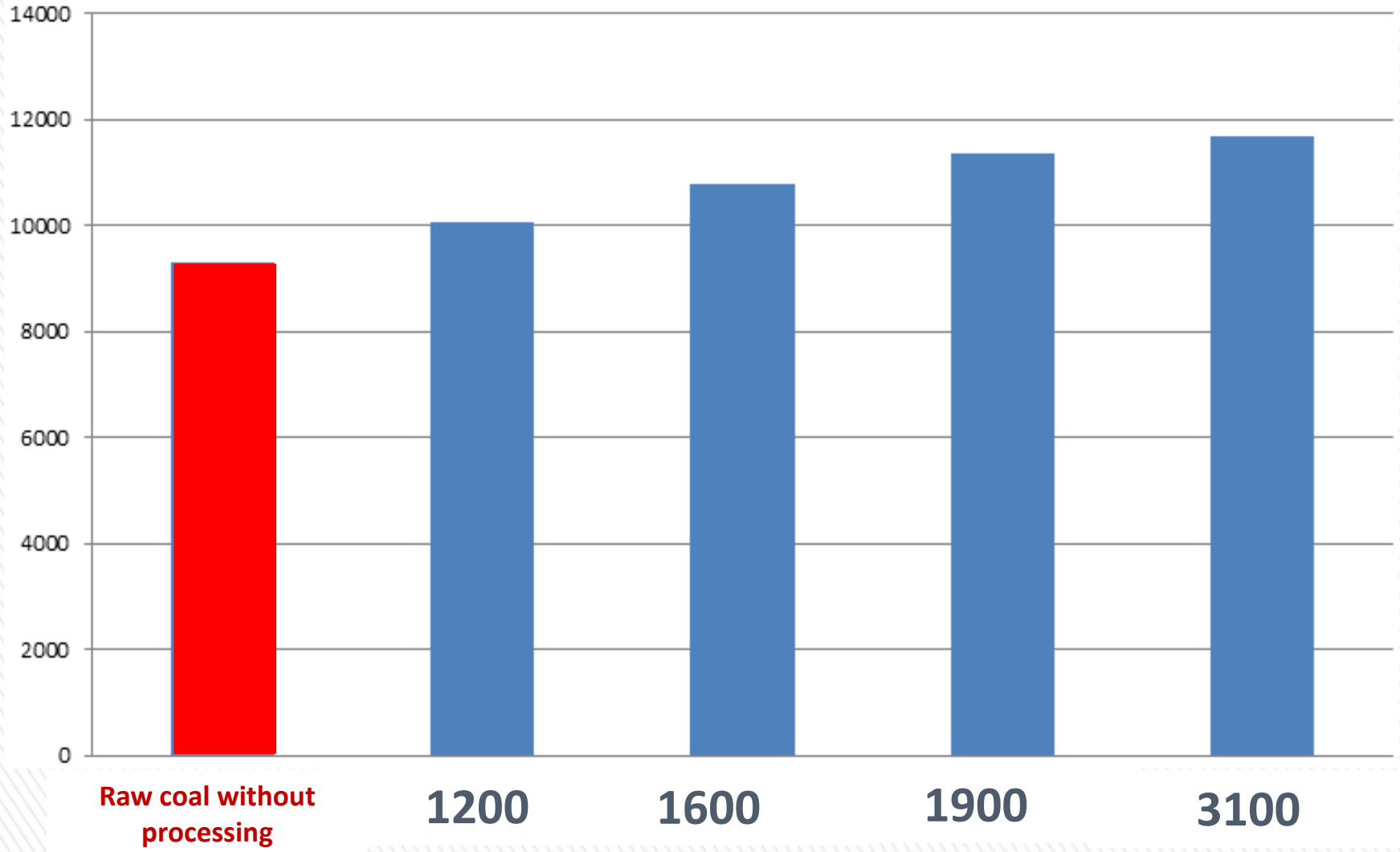
GCS 1st PP Processed PRB Analysis – Heating Value

Values in Btu/lb



- As-Received Btu Content: improved by **26%**

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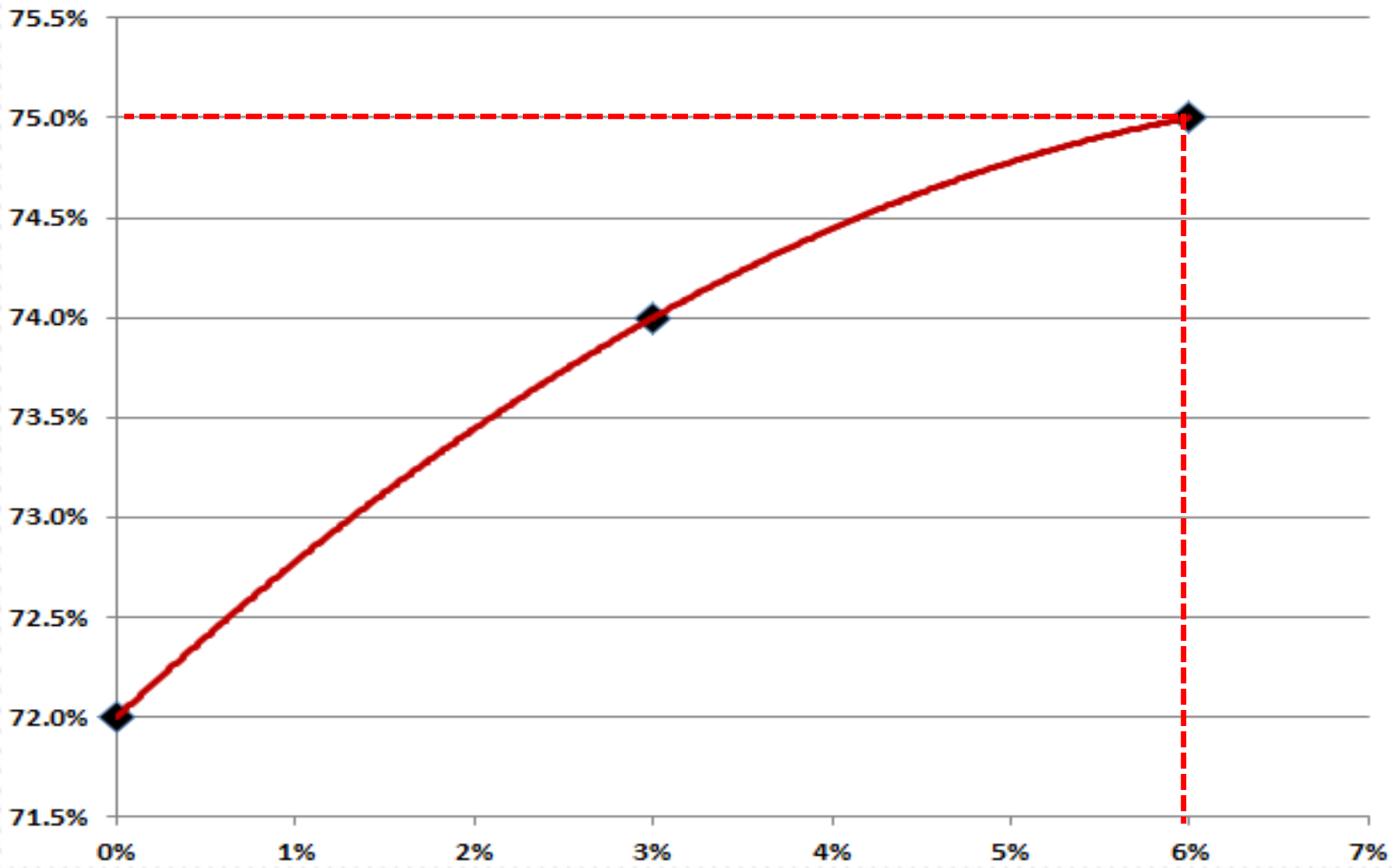
GCS 1st PP Moisture Reduction VS. Combustion Efficiency



- When coal moisture content is reduced by **6**% from 38% to 32%, the combustion efficiency is expected to improve by **3%**,

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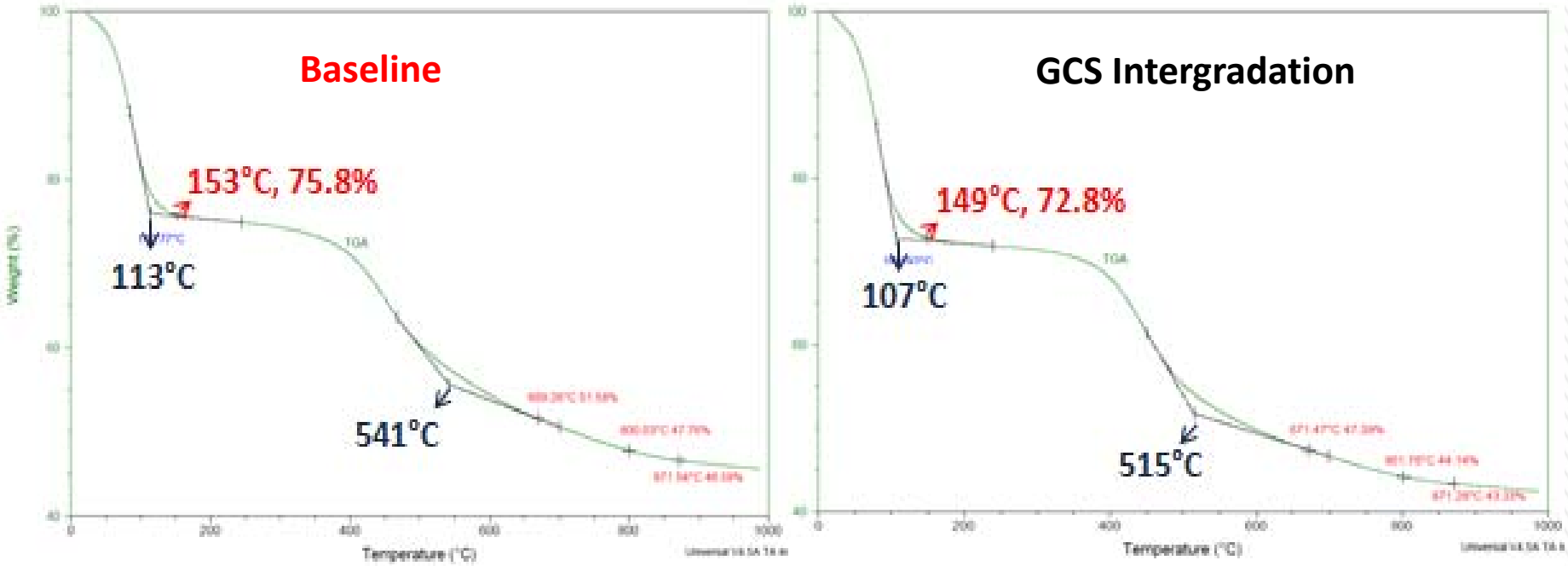
TGA on GCS Intergradation (1st PP +2nd ET)



- During combustion, moisture content is reduced by **3%** more at the similar temperature level ~150°C
- Complete combustion happens Approximately **25°C (77°F)** faster

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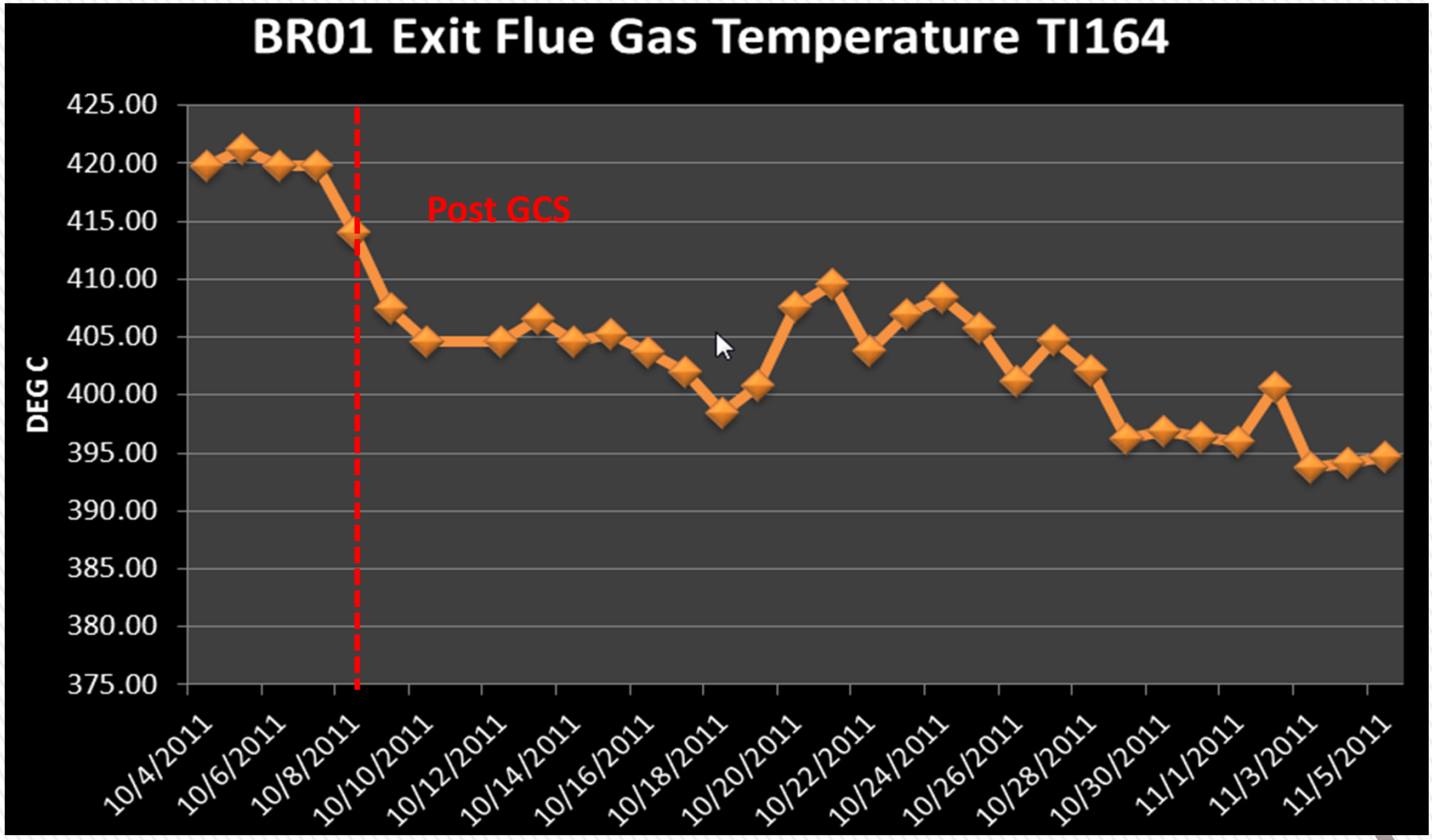
GCS (2nd ET) Plant Performance – Boiler Exit Temperature



GCS improves thermal efficiency which lower flue gas temperature.

(420°C - pre GCS vs. 395°C – Post GCS)

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GCS 2nd ET Plant Performance – Soot Blowing Intervals

Without GCS, the normal soot-blowing was **5-6** times a day at **430°C**

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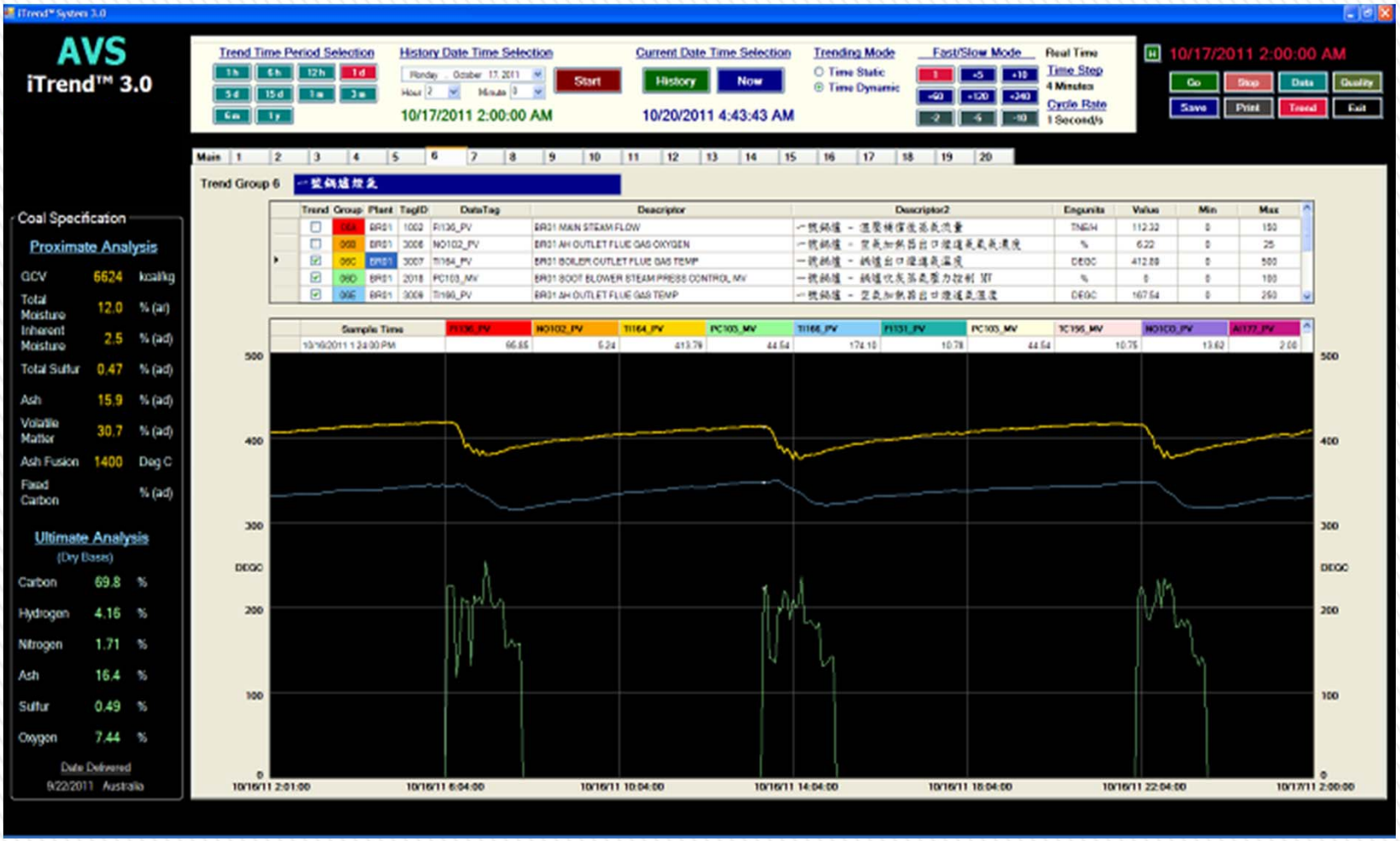
GCS 2nd ET Plant Performance – Soot Blowing Intervals



With GCS, the improved soot-blowing was **2-3** times a day at **400°C**

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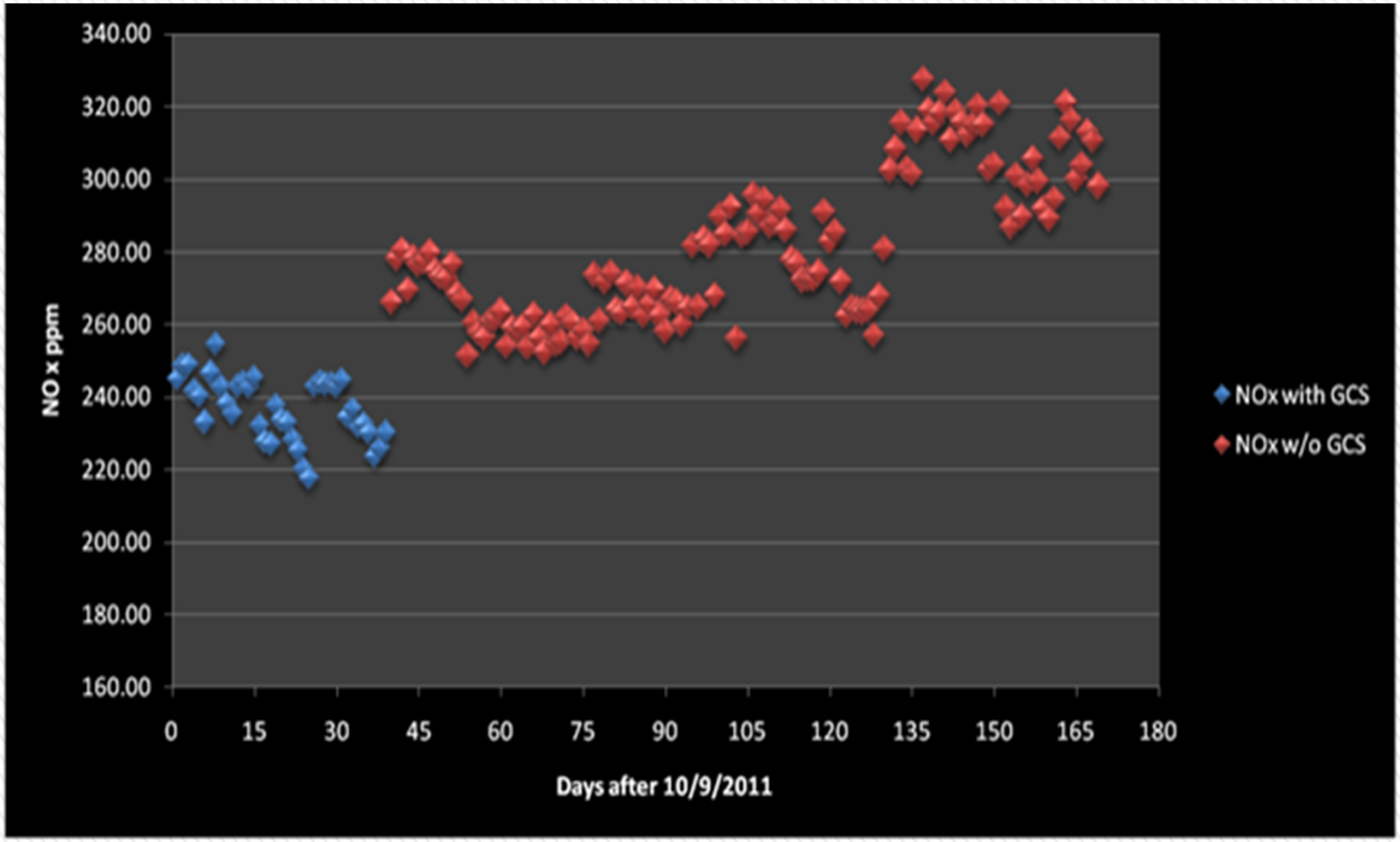
GCS 2nd ET Plant Performance – NOx Reduction



The GCS application improves about **22.4%** in NO_X emission reduction. For some PRB or lignite fired applications, 20% -25% is about the best performance for SNCR without creating huge NH3 slip.

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GCS 2nd ET Plant Performance – SO_2 Emission

This steam plant has a FGD facility to reduce SO_2 emission by applying Magnesium Oxide (MgO). The 6 months average of coal treated by one ton of MgO without **GCS** is about **93.3 (tones of coal)** comparing to **122.0 (tons of call)** on 3 months average with **GCS**

The SO_2 emission reduction is determined at **30.8%**

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GCS Intergradation Process Equipment

Figure 1 GCS Equipment layout

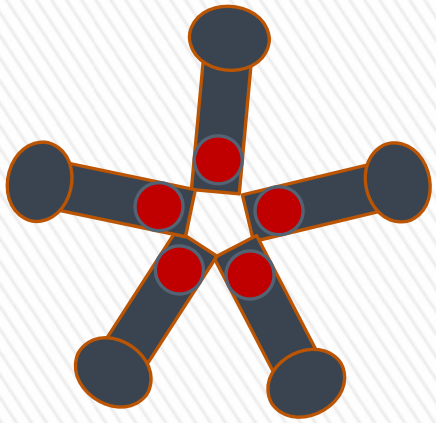

Figure 2 Multi-GCS Configuration

The GCS Process equipment (Figure 1) capabilities at **70** tons/hr estimated throughput:

- ✓ The machine can process **50,000** metric tons /month /machine on a continuous 24/7 operation basis.
- ✓ There is no issue on the wearing because there is no rolling or milling parts within the equipment.
- ✓ This works out to about **600,000** metric tons processed /year/machine

For a coal operation requires **2,400,000** metric tons per year processed the number of GCS machines would need to be ***four (4) sets of GCS equipment in service and one for redundancy.*** That would generate **200,000** metric tons per month of processed coal.

Footprint:

- ✓ The basic (one set of) GCS application on a **4 m x 14 m area (not including conveyor belt ingress and egress) (**to install four sets of GCS equipment, it requires enough area to place the four units which would take up the same space unless the configuration and placement of the feed conveyor was engineered in a manner that requires additional space surrounding each machine which could add over 35 m feet of surrounding area per machine.)
- ✓ An octopus configuration is recommended (Figure 2) where one single conveyor system could accommodate the 6,451 tons per day required to process 200,000 tons per month. ***This configuration will require 45 M * 45 M in space***
- ✓ ***The power requirement is standard 3 phase 480V***

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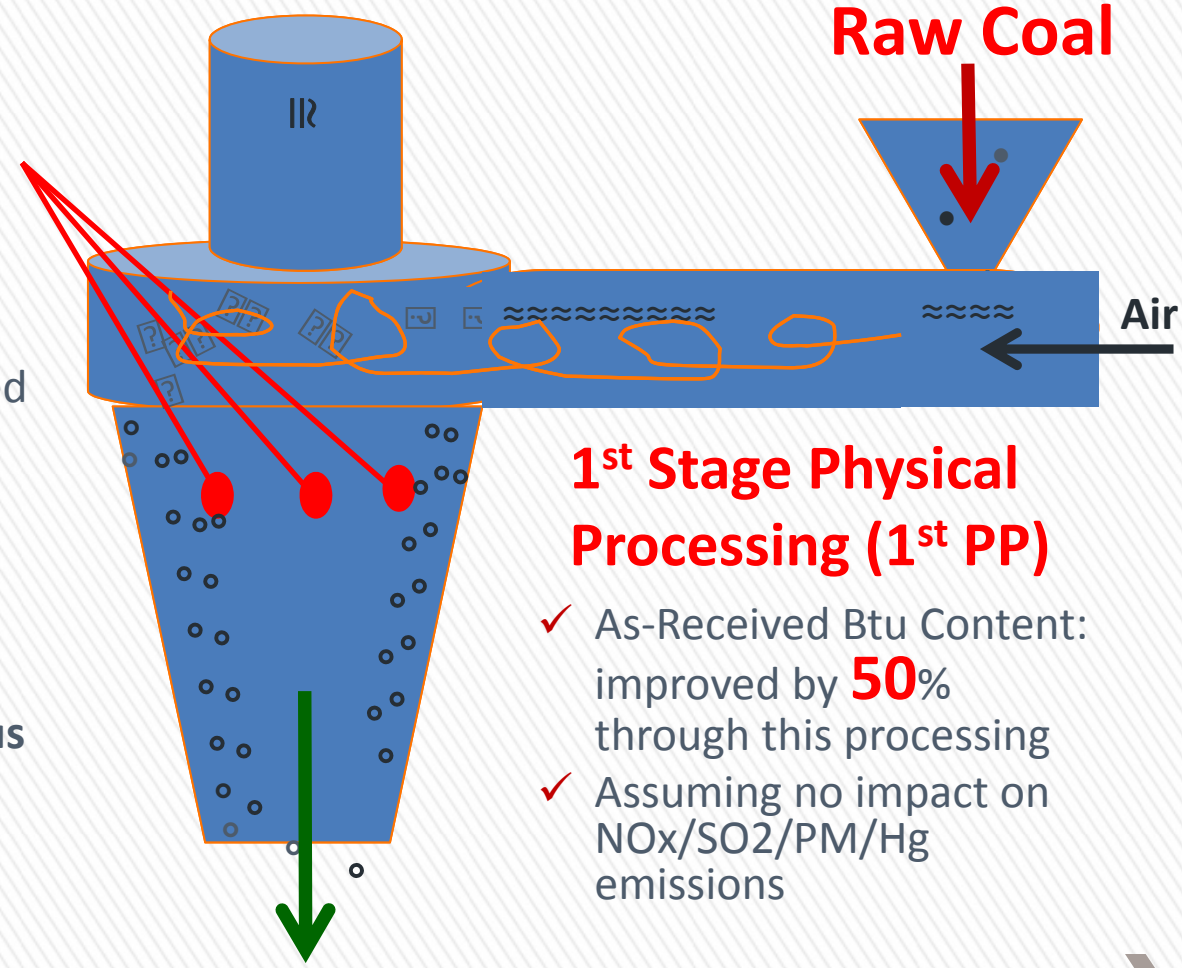

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Processed Green Coal for Combustion or Storage

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Observations and Conclusions

- ✓ Improves coal heating value per pound by **26% - 50%** (from the single path processing to the double path processing), and reduces coal ash content by **25%** which immediately upgrades the market values of the low-grade subbituminous and lignite coals.
- ✓ Boiler (combustion) efficiency has been estimated to improve by **5.3% - 9.3%** which results in reduction of annual coal consumption by approximately **7.3%.**
- ✓ Approximately **25°C (77°F)** reduction in boiler exit temperature from less scale, soot and slag deposits on boiler tubes and furnace wall which reduces outage frequency to remove slag deposits and costly fluxing agents to reduce slag and scale.
- ✓ Decreases excess air by approximately **15%** due to improvement in coal combustibility from application of bio-enzymatic fuel additive.
- ✓ The combination of reduced coal ash content **(23%-42%)** by the1st PP and physical alteration of fly ash by the 2nd ET will result in reduction in fouling/scaling thus reducing soot-blowing intervals saving steam and less impact on tube erosion further improving plant reliability.

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Observations and Conclusions

- ✓ The projected reduction of **7.3%** on annual coal consumption directly results in the reduction of CO_2 emissions by approximately **7.3%** at a market price of **$5 - $6 /ton CO_2e** (carbon credit).
- ✓ The combination of lower boiler exit temperature and reduced annual coal consumption produces overall reduction in NO_X emissions (includes thermal NOx and fuel NOx) by approximately **25%.**
- ✓ The combination of reduced annual coal consumption and application of the **2nd ET ™** produces overall reduction in SO_2 emissions by approximately **35%**.
- ✓ This produces conservatively **35%** reduction in wet scrubber SO_2 control related consumables (lime, limestone, DBA, etc.) and **25%** reduction in NO_X control related consumables (ammonia, urea, etc.).
- ✓ Therefore, the GCS could potentially extend the life of post-combustion hardware and improve the performance efficiencies, such as Selective Catalyst Reduction **(SCR),** Air Preheater **(APH),** Electrostatic Precipitator **(ESP)** and Flue Gas Desulfurization Scrubber **(FGD)**

Observations and Conclusions

- ✓ Reduction of unburned carbon in fly ash and bottom ash as measured by loss-on-ignition (LOI) allowing it to become an economic by-product for sale rather than being sent to an expensive landfill at **~$20 /ton**.
- ✓ Observed improved hydrophobicity (repel water) and reduction in spontaneous combustion to allow ease of coal storage in outdoor coal piles thus prevents coal degradation during shipment and storage (if applied at the mining source)
- ✓ Due to less consumption of coal, the physical quantities of metal pollutants including mercury **(Hg),** selenium **(Se),** arsenic **(As),** and lead **(Pb),** etc. can also be reduced.

Please contact:

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B&CES B&C Energy Services, Inc.

CLIMATE CHANGE AND EMISSIONS MANAGEMENT
(CCEMC) CORPORATION

P.O. Box 3197, Sherwood Park, AB
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December 12, 2013

Mr. Bobby I.T. Chen
President
B&C Energy Services, Inc
814 Biscaynne Ct.
Bowling Green, Kentucky 42101

EOI #G130058

Dear Mr. Chen:

Congratulations, your project was selected to go forward to the Full Project Proposal (FPP) stage of the CCEMC's funding process.

Please note that the **Cleaner Fossil Fuel Production and Processing** FPP Guide and Instructions, GHG Emission Reduction Guidance Document and Cost Guide and Instructions are posted at http://ccemc.ca/apply/full-project-proposals/ . Please adhere to these instructions when preparing your proposal. Your FPP and GHG Reduction Emissions report must be submitted online by the deadline date of February 6, 2014 at 4:30 PM MST (UTC-7h)

In addition, Vicki Lightbown has been assigned as your project advisor, and will assist you during the development of your proposal. Any project related questions should be directed to Vicki who will be in touch with you shortly to discuss next steps. Vicki can be reached at (vicki.lightbrown@albertainnovates.ca or 780-638-4343).

We look forward to receiving your Full Project Proposal and to the outcomes of this next phase of the process.

Sincerely,

KIRK ANDRIES
Chair, Operations Management Committee

Cc: Vicki Lightbown
Kate Wilson

CLIMATE CHANGE AND EMISSIONS MANAGEMENT
(CCEMC) CORPORATION

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December 12, 2013

Mr. Walter Fuqua
Managing Member
Mineral Management I, LLC
1117 Glyndon Rd
Plano, Texas 75023

EOI #G130049

Dear Mr. Fuqua:

Congratulations, your project was selected to go forward to the Full Project Proposal (FPP) stage of the CCEMC's funding process.

Please note that the **Cleaner Fossil Fuel Production and Processing** FPP Guide and Instructions, GHG Emission Reduction Guidance Document and Cost Guide and Instructions are posted at http://ccemc.ca/apply/full-project-proposals/ . Please adhere to these instructions when preparing your proposal. Your FPP and GHG Reduction Emissions report must be submitted online by the deadline date of February 6, 2014 at 4:30 PM MST (UTC-7h)

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We look forward to receiving your Full Project Proposal and to the outcomes of this next phase of the process.

Sincerely,

KIRK ANDRIES
Chair, Operations Management Committee

Cc: Kate Wilson